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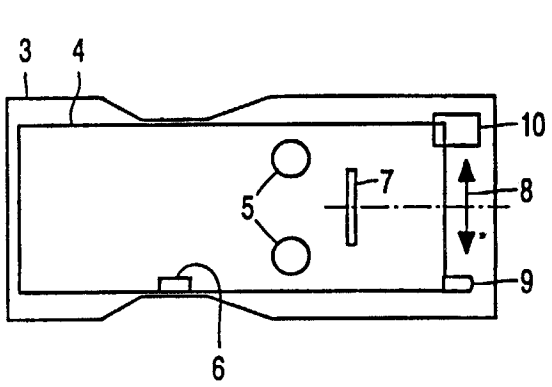

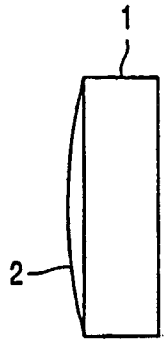

(57) Abstract

The invention relates to a remote control apparatus for controlling a display apparatus. The remote control comprises an image sensor (7) and imaging optics (8) for projecting an image, for example of the display screen (2), on the image sensor. If a user moves the remote control apparatus, the projected image will move accordingly. From the movement of the projected image, a relative movement of the remote control apparatus with respect to the display apparatus is deduced, and converted to control commands which are transmitted to the display apparatus.

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Remote control for display apparatus.

FIELD OF THE INVENTION

The invention relates to a remote control apparatus for controlling a display apparatus, comprising orientation means for detecting a relative movement of the remote control apparatus with respect to the display apparatus.

The invention further relates to a system of a display apparatus and the above remote control apparatus.

The invention further relates to a display apparatus for use in the above system.

BACKGROUND OF THE INVENTION

With the advent of advanced features for television, such as Internet browsing, home shopping and game playing, the user must be enabled to control these new features from the usual viewing distance. For that reason, a remote control is needed which integrates the functions of a conventional remote control and a pointing device, such as a computer mouse. Various solutions have been proposed for this integration. Some of them are based on the technology applied in a light-pen, wherein the moment of detecting a light spot caused by the cathode ray of the display apparatus is compared with the synchronization signals. This solution is only applicable within a limited distance from the display screen. Other solutions are based on an infrared signal which is transmitted by the display apparatus and received by the remote control. For example, US 5,644,126 discloses a system of a display apparatus and a remote control, the display apparatus having a light source, e.g. a photodiode, the light of which is received by the remote control and led through a lattice. The resultant interference pattern is projected onto an array sensor. If the remote control is moved, the interference pattern shifts, which can be detected by means of the array sensor. The movement is then converted to appropriate commands for controlling functions of the display apparatus, e.g. choosing a menu option from an on-screen display menu.

A disadvantage of the known systems is that both the remote control and the display apparatus need to be adapted to achieve the desired functionality. Hence, they do not provide a remote control which can be applied as an add-on to conventional display

apparatuses. Furthermore, only relative movements can be detected with the system of US 5,644,126.

OBJECT AND SUMMARY OF THE INVENTION

It is an object of the invention to provide a remote control apparatus of the type defined in the opening paragraph which evades the disadvantages of the remote control apparatuses of the prior art. To this end, the remote control apparatus according to the invention is characterized in that the orientation means comprise an image sensor and imaging optics for projecting an image on the image sensor, the orientation means being adapted to deduce said movement from a movement of the projected image. The projected image may be of any object, e.g. the display screen, a window or a lamp. If the user moves the remote control apparatus, the projected image will move accordingly. The movement of the projected image can be detected, e.g. by comparing subsequent frames obtained from the image sensor. Software algorithms for detecting and analyzing the movement of the projected image are known per se and will only be discussed in so far as they are relevant for disclosing the invention. Background information may be obtained from, for example:

- A method for processing laser speckle images to extract high-resolution motion, Andrew Houghton, Graham Rees and Peter Ivey Measurement Science & Technology no 8 (1997), pages 611-617 IOP publishing Ltd.
- Linear and rotary encoders using electronic speckle correlation, Ichirou Yamagouchi and Tadashige Fujita, Optical Engineering / December 1991 / vol. 30 No. 12, pages 1862 – 1868.

The movements of the projected image are then translated into appropriate commands for controlling functions of the display apparatus, e.g. a cursor position. An additional advantage of the invention is that rotation can be detected as well.

An embodiment of the remote control apparatus according to the invention is characterized in that the remote control apparatus further comprises activation means for activating the orientation means in response to a user command or predetermined event. The activation means may comprise a grip or tilt sensor for detecting the event of picking up the remote control apparatus. Alternatively, the activation means may comprise a button which has to be pressed intentionally to activate the orientation means. Upon activation, the remote control apparatus may perform initialization actions, e.g. to provide a default cursor position. All subsequent movements will then be translated into corresponding cursor movements.

A further embodiment is characterized in that the remote control apparatus further comprises distance measuring means for measuring a distance to an object of which an image is projected on the image sensor, the orientation means being adapted to adjust said relative movement with respect to said distance. For example, the remote control apparatus may be equipped with an auto-focus unit. On the one hand, the auto-focus unit guarantees a sharp projected picture on the image sensor independent of the distance to the projected object. On the other hand, the auto-focus unit may provide information with respect to the distance between the remote control apparatus and said object, which information may be taken into account when determining the sensitivity of the orientation means. For example, when aiming the remote control apparatus at a nearby object, a movement of the remote control apparatus will cause a relatively large movement of the projected image. In that case, the movements may be translated into relatively small cursor movements in comparison to the situation of aiming at a remote object. Techniques for auto-focussing are well known, see for example:

- Digital method for measuring the focus error, by Adolf W. Lohmann, David Mendiovic, and Zeev Zalevsky APPLIED OPTICS / vol. 36. No. 28 / 1 October 1997, pages 7204-7209,
- Speckle techniques for absolute distance measurement, G.E. Hege, H.J. Tiziani, Tech. Messen 54 (6) pages 237 - 242 (1987).

A further embodiment is characterized in that the orientation means are further adapted to recognize an image of the display apparatus. As mentioned before, the display apparatus itself may be conveniently used as an object to aim at. Generally, the display screen is salient in the viewing environment because of its light production. For the purpose of controlling objects displayed on the display screen, specific properties of the display screen may advantageously be taken into account. For example, the dimensions of the screen and/or the picture refresh rate may be used to distinguish the screen from the environment.

A further embodiment is characterized in that the orientation means are further adapted to store properties (dimensions, refresh rate) of the display apparatus. By explicitly storing such properties, e.g. by downloading or explicitly entering them by means of the buttons, the orientation means have a priori knowledge about the projected image of the display apparatus. Hence, confusion caused by, for example, the flickering of lamps or the dimensions of windows can be avoided.

A further embodiment is characterized in that the orientation means are adapted to recognize an icon with predetermined properties on the display of the display apparatus. In this way it is achieved that the display screen can be recognized unambiguously, because the

icon can be made unique by means of a specific shape or color combination. The icon may be located in a fixed position, or it may double as the screen cursor.

A further embodiment is characterized in that said predetermined properties comprise a periodic change of predetermined parameters (e.g. color, brightness). In this way, the unambiguous recognition of the display apparatus is further simplified.

A further embodiment is characterized in that the remote control is adapted to decode status information related to the display apparatus from said periodic change. The periodic change of the previous embodiment may be modulated with signals representing said status information. The status information may comprise sensitivity settings, properties of the display apparatus etc.

An embodiment is characterized in that the orientation means are further adapted to determine a relative position of the remote control apparatus with respect to the display apparatus by deducing said relative position from the projected image of the display apparatus. In this way, not only relative positioning, but also absolute positioning becomes feasible, because after recognition of the display screen the necessary properties, such as screen dimensions, are available to the orientation means.

The invention is particularly suitable for television receivers, monitors, (game)computers and presentation devices.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of the invention are apparent from and will be elucidated, by way of a non-limitative example, with reference to the embodiment(s) described hereinafter. In the drawings,

Figure 1 schematically shows a remote control apparatus and a display apparatus according to the invention,

Figure 2 shows a block diagram of the relevant elements of a remote control apparatus according to the invention,

Figure 3 shows various types of movement which are detected by a remote control apparatus according to the invention,

Figure 4 schematically shows absolute cursor positioning by means of a remote control apparatus according to the invention,

Figure 5 shows an example of information transfer from a display apparatus to a remote control apparatus according to the invention.

DESCRIPTION OF EMBODIMENTS

Figure 1 shows a television receiver 1 comprising a display screen 2, and a remote control 3. The remote control 3 comprises a circuit board 4 and buttons 5 which have the same function as the buttons of a computer mouse. Additionally, conventional remote control buttons may be provided, e.g. numerical keys, teletext keys etc. The remote control 3 further comprises a grip sensor 6 for detecting when the remote control is picked up by a user. Imaging optics 8 are capable of projecting an image of a remote object, e.g. the television receiver 1, onto an image sensor 7 which is placed on the circuit board 4. A LED (Light Emitting Diode) 9 is mounted on the circuit board 4 for transmitting infrared light signals to the television receiver 1. An auto-focus unit 10 is provided for establishing a sharp projection upon the image sensor 7 and for measuring the distance to the projected object.

Figure 2 shows a block diagram of the relevant elements of the remote control 3. An image of the display screen 2 is projected onto the image sensor 7, which is a matrix of photo-sensitive cells, e.g. photo-diodes or integrating photo-cells. The photo-sensitive cells (pixels) are scanned periodically by addressing them by means of a pixel addressing unit 13. The resultant electric signal is converted by an A/D converter 14 and transmitted to a signal processor 12 in digital form. The signal processor 12, constituting orientation means for detecting a relative movement with respect to a display apparatus to be controlled, is capable of extracting salient distinctive elements from the available information. Software algorithms for detecting such elements are known per se. For example, the signal processor 12 may look for transitions between light and dark areas whose dimensions and contrast values exceed a certain threshold. Suitable elements the signal processor 12 may look for are the corners of the display screen 2, a cursor or other elements of the displayed content. Alternatively, correlation techniques may be used for the extraction of salient elements. These techniques are known per se.

The coordinates of said elements are stored in a memory (not shown). By storing the coordinates of at least two elements, both translation along two coordinate axes and rotation can be detected. Periodically, e.g. every frame or averaged over a number of frames, the measured translation or rotation will be converted to appropriate commands for controlling the television receiver 1, and transmitted to the television receiver 1 by means of infrared signals generated by the LED 9, or by means of an alternative transmission method. The signal processor 12, or another dedicated circuit, generates the codes to be transmitted from the

computed translation and rotation, together with the state of the buttons 5 and the grip sensor 6.

The grip sensor activates signal processor 12 when the remote control 3 is operated by the user. Upon activation an initialization routine is started which performs the following functions:

- Transmitting an initialization code to the television receiver 1, causing a cursor and/or menu to be activated.
- Capturing an image from the image sensor
- Determination of the coordinates of salient elements of the image, and computing relative translation or rotation by means of correlation techniques.

For the recognition of image elements it is not necessary to take all pixels into account. Only the pixels close to such an element need to be stored and processed, thus saving processing power. Dependent on the required response times, detected movements may be averaged over multiple measurements before transmitting corresponding commands to the television receiver 1.

The recognition of the display screen 2 may be enhanced by taking specific properties of the display screen 2 into account. Generally, displays are characterized by a specific refresh rate, which ranges from 25 Hz (classical TV) to 160 Hz. This refresh rate can be detected, and this can be used to determine which information on the image sensor 7 is obtained from the display screen 2. From this information the salient elements can then be extracted. Elements consist of light-dark transitions with a certain contrast and dimensions. For a reliable recognition at least a few pixels should be involved.

If the position of two elements at a time t is given by (x0,y0)(t) and (x1, y1)(t) respectively, translation and rotation with respect to point (x0, y0) can be calculated by determining the coordinates of the two points at two subsequent points in time t0 and t1 as, respectively, (x0, y0) (t0), (x1, y1) (t0) and (x0, y0) (t1), (x1, y1) (t1).

Now translation is defined as:

- $dx = x0\ (t1) - x0\ (t0)$
- $dy = y0\ (t1) - y0\ (t0)$

Rotation is defined as:

- $\Theta = \arctan((x1(t1) - x1(t0) - dx)/(y1(t1) - y1(t0) - dy))$.

Figure 3 shows the various degrees of freedom of the remote control 3.

All measures discussed can be applied without adapting the software or hardware of the display apparatus to be controlled. Additional reliability and functionality may be obtained by

adapting the displayed content on the display screen 2 in a predetermined way. For example, a cursor may be hard to detect within the unpredictable content of the displayed picture. This problem may be solved by periodically changing some properties of the cursor, e.g. its intensity. By switching the cursor on and off at regular times, e.g. every other refresh cycle, the detector is able to clearly distinguish the cursor from the displayed picture. By filtering over time, the cursor position can be determined reliably.

The absolute position with respect to the display screen 2 may be determined by comparing its position with the fixed positions of further elements. Figure 4 shows a cursor 15 having position (Xc, Yc) and two elements 16 and 18 at positions (X2,Y2) and (X1,Y1) respectively. The presence of a third element 17 at position (X0,Y0) will enhance the reliability of the computations. By choosing fixed positions for the further elements, e.g. the corners of the display screen, the signal processor 12 is able to infer the screen diameter. The absolute position (X,Y) of the cursor 15 is defined as:

- $X = xc/(x2 - x1)$
- $Y = yc/(y2 - y1)$

The periodical change of cursor properties may be modulated in order to transmit information from the display apparatus 1 to the remote control 3. For example, information related to the status of the display apparatus 1, or a desired change of sensitivity of the remote control 3, may be transferred to the remote control 3. Cursor modulation is achieved by controlling the periodic change with codes representing the information to be transmitted.

This is illustrated in Figure 4. The step function 19 represents the frame cycle, the high level representing the even frames, and the low level representing the odd frames. The step function 20 represents the cursor signal, the high level representing 'cursor on', and the low level representing 'cursor off'. Techniques for encoding information are well known per se.

In summary, the invention relates to a remote control apparatus for controlling a display apparatus. The remote control comprises an image sensor and imaging optics for projecting an image, for example of the display screen, on the image sensor. If a user moves the remote control apparatus, the projected image will move accordingly. From the movement of the projected image, a relative movement of the remote control apparatus with respect to the display apparatus is deduced, and converted to control commands which are transmitted to the display apparatus.

Although the invention has been described with reference to particular illustrative embodiments, variants and modifications are possible within the scope of the inventive concept.

The word 'comprising' does not exclude the presence of elements or steps other than those listed in a claim.

CLAIMS:

1. A remote control apparatus for controlling a display apparatus, comprising orientation means for detecting a relative movement of the remote control apparatus with respect to the display apparatus, characterized in that the orientation means comprise an image sensor and imaging optics for projecting an image on the image sensor, the orientation means being adapted to deduce said movement from a movement of the projected image.

2. A remote control apparatus as claimed in claim 1, characterized in that the remote control apparatus further comprises activation means for activating the orientation means in response to a user command or predetermined event.

3. A remote control apparatus as claimed in claim 1 or 2, characterized in that the remote control apparatus further comprises distance measuring means for measuring a distance to an object of which an image is projected on the image sensor, the orientation means being adapted to adjust said relative movement with respect to said distance.

4. A remote control apparatus as claimed in claim 1 or 3, characterized in that the orientation means are further adapted to recognize an image of the display apparatus.

5. A remote control apparatus as claimed in claim 4, characterized in that the orientation means are further adapted to store properties (dimensions, refresh rate) of the display apparatus.

6. A remote control apparatus as claimed in claim 4 or 5, characterized in that the orientation means are adapted to recognize an icon with predetermined properties on the display of the display apparatus.

7. A remote control apparatus as claimed in claim 6, characterized in that said predetermined properties comprise a periodic change of predetermined parameters (e.g. color, brightness).

8. A remote control apparatus as claimed in claim 7, characterized in that the remote control is adapted to decode status information related to the display apparatus from said periodic change.

9. A remote control apparatus as claimed in anyone of claims 4 to 8, characterized in that the orientation means are further adapted to determine a relative position of the remote control apparatus with respect to the display apparatus by deducing said relative position from the projected image of the display apparatus.

10. A system of a display apparatus and a remote control apparatus having the features of the remote control apparatus as defined in claims 4 to 9, characterized in that the display apparatus is adapted to display an icon with predetermined properties for enhancing the recognizability of an image of the display apparatus when projected onto the image sensor of the remote control apparatus.

11. A display apparatus having the features of the display apparatus of the system as defined in claim 10.

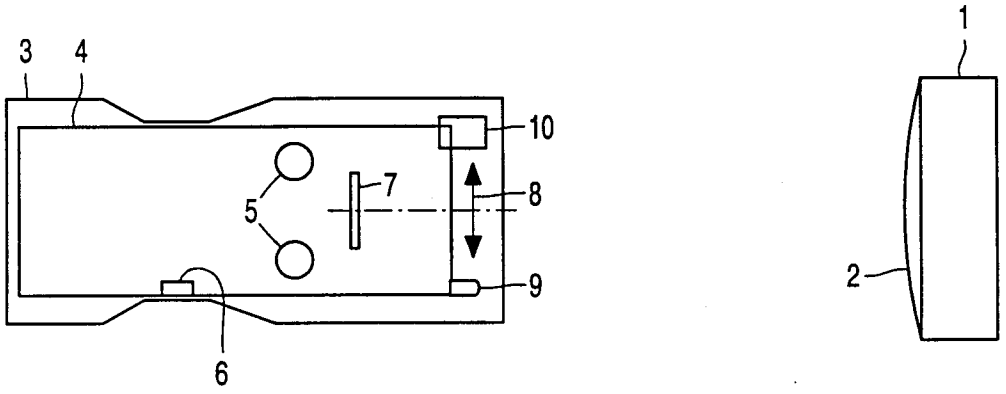

FIG. 1

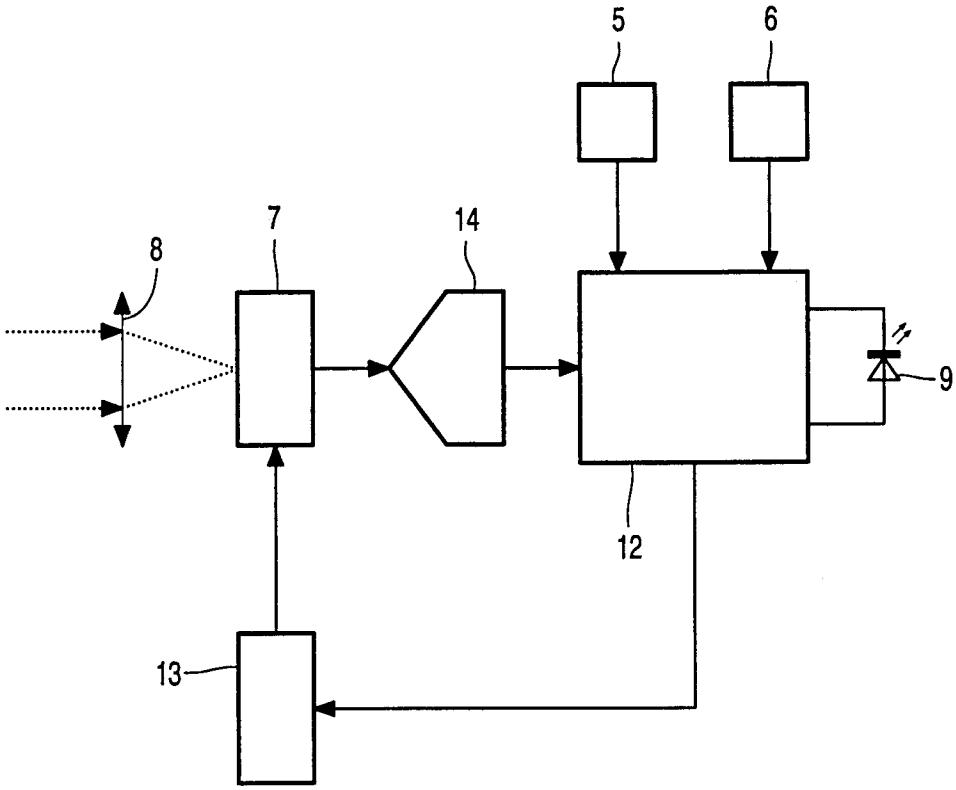

FIG. 2

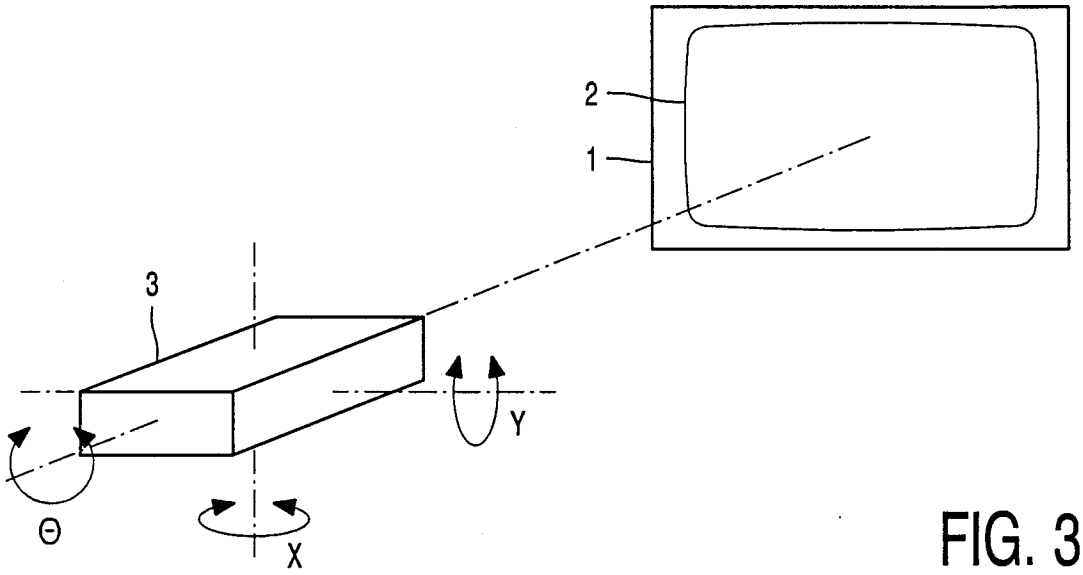

FIG. 3

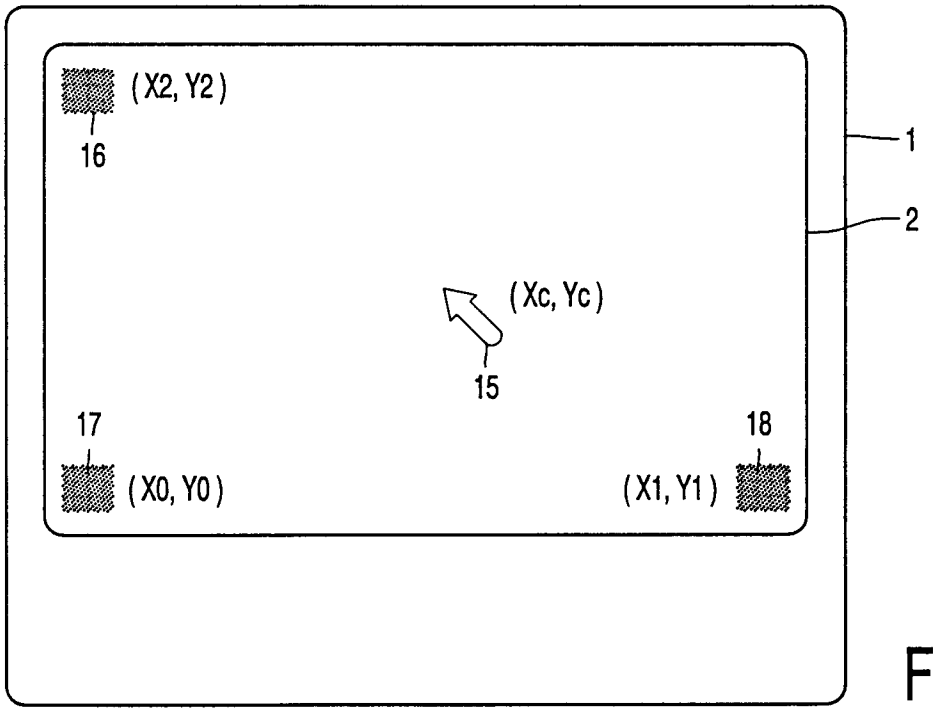

FIG. 4

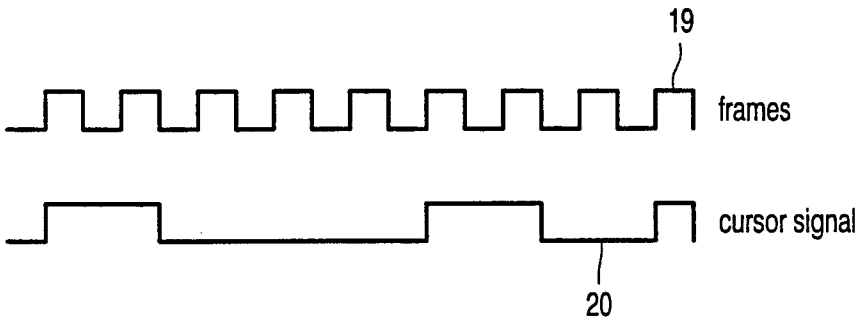

FIG. 5

INTERNATIONAL SEARCH REPORT

Internati Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G06K11/08 G06K11/18 G06F3/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G06K G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
WPI Data, EPO-Internal, PAJ, IBM-TDB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	PATENT ABSTRACTS OF JAPAN vol. 1995, no. 08, 29 September 1995 (1995-09-29) -& JP 07 121293 A (NIPPON TELEGR & TELEPH CORP), 12 May 1995 (1995-05-12) abstract	1,4
Y	--- EP 0 838 751 A (RANK XEROX LTD) 29 April 1998 (1998-04-29) column 6, line 43 - line 52	3
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 138 304 A (BRONSON BARRY) 11 August 1992 (1992-08-11) column 4, line 27 - line 54	5,6
A	PATENT ABSTRACTS OF JAPAN vol. 1995, no. 10, 30 November 1995 (1995-11-30) & JP 07 191799 A (TOSHIBA CORP), 28 July 1995 (1995-07-28) abstract	2
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Information on patent family members

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